

What Is Claimed:

1. A process for applying a lubricious coating to a surface of a medical device comprising:

providing a medical device made from a polymer;

5 contacting a surface of the medical device with a solvent and a multi-functional monomer, the solvent causing the multi-functional monomer to be imbibed into the surface of the medical device, the multi-functional monomer comprising an acrylate or an ammonium compound;

drying the surface of the medical device; and

10 providing and polymerizing a polymer on the surface of the medical device, the polymer reacting with the multi-functional monomer imbibed into the surface of the device to form a lubricious coating.

2. A process as defined in claim 1, wherein the polymer polymerizing on the surface of the medical device and reacting with the multi-functional monomer is a hydrogel polymer.

3. A process as defined in claim 2, wherein the surface of the medical device is made from a thermoplastic or a thermoset polymer.

4. A process as defined in claim 2, wherein the surface of the medical device is made from polyvinyl chloride.

5. A process as defined in claim 2, wherein the solvent causes the surface of the medical device to swell and/or partially dissolve.

6. A process as defined in claim 2, wherein the solvent comprises dimethyl sulphoxide, acetone, methylethyl ketone, toluene, alcohol, or xylene.

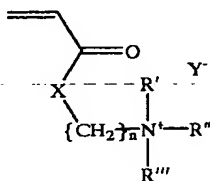
7. A process as defined in claim 2, wherein the surface of the medical device is further contacted with an initiator.

8. A process as defined in claim 7, wherein the initiator comprises 1-hydroxycyclohexyl phenyl ketone, α -hydroxy-1, adimethylacetophenone, benzoyl peroxide, azo-bis-isobutyro-nitrile, di-t-butyl peroxide, bromyl peroxide, cumyl peroxide, lauroyl peroxide, isopropyl percarbonate, methylethyl ketone peroxide, 5 cyclohexane peroxide, t-butylhydroperoxide, di-t-amyl peroxide, dicumyl peroxide, t-butyl perbenzoate, a benzoin alkyl ether, a benzophenone, a acetophenone, a thioxanthone, benzyl 2-ethyl anthraquinone, methylbenzoyl formate, 2-hydroxy-2-methyl-1-phenyl propane-1-one, 2-hydroxy-4'-isopropyl-2-methyl propiophenone,

10 e-hydroxy ketone, tet-remethyl thiuram monosulfide, an allyl diazonium salt, camphorquinone or 4-(N,N-dimethylamino) benzoate.

9. A process as defined in claim 2, wherein the multi-functional monomer and solvent are combined into a solution when contacting the surface of the medical device and wherein the multi-functional monomer cross-links the hydrogel polymer.

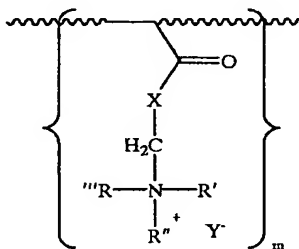
10. A process as defined in claim 2, wherein the hydrogel polymer comprises:



5 wherein n is an integer of 2 to 3; R', R'' and R''' are independently selected from the group consisting of H, C₁ to C₁₆ alkyl, aryl, arylamine, alkylamine, alkaryl and aralkyl; X is selected from the group consisting of O and NH; and Y⁻ is an acceptable anionic counterion to the N⁺ of the quaternary amine.

11. A process as defined in claim 2, wherein the hydrogel polymer is polymerized by:

contacting the surface of the medical device with a monomer comprising:



5 wherein R', R'' and R''' are independently selected from the group consisting of H, C₁ to C₁₆ alkyl, aryl, arylamine, alkylamine, alkaryl and aralkyl; X is selected from

the group consisting of O and NH; Y⁻ is an acceptable anionic counterion to the N⁺ of the quaternary amine; m is an integer greater than 50,000;

10 and thereafter initiating polymerization.

12. A process as defined in claim 11, whereas polymerization is initiated by exposing the surface of the medical device with ultraviolet light.

13. A process as defined in claim 2, whereas a medical device is a tracheal suction device, a catheter, a guidewire, a stylet, an introducer, an enternal feeding device, or an endotracheal tube.

14. A process as defined in claim 2, wherein the surface of the medical device comprises a silicone or a urethane.

15. A process as defined in claim 2, wherein the hydrogel polymer is made from a monomer comprising an acryloyloxyalkyl-trialkyl-substituted ammonium salt, an acryloyloxyalkyl-aryl-substituted ammonium salt, an acrylamidoalkyl-trialkyl-substituted ammonium salt, or an acrylamidoalkyl-aryl-substituted ammonium salt.

16. A process as defined in claim 2, wherein the hydrogel polymer is made from a monomer comprising acryloyloxyethyltrimethyl ammonium chloride, or acryloyloxyethyltrimethyl ammonium methyl sulfate.

17. A process as defined in claim 2, wherein the multi-functional monomer comprises an alkoxylated acrylate.

18. A process as defined in claim 2, wherein the multi-functional monomer comprises a triacrylate.

19. A process as defined in claim 2, wherein the multi-functional monomer comprises a tetraacrylate, a pentaacrylate, a hexaacrylate, or a diacrylate.

20. A process as defined in claim 2, wherein the multi-functional monomer comprises an ethoxylated trimethylolpropane triacrylate, a propoxylated glyceryl triacrylate, trimethylolpropane triacrylate, pentaerythritol triacrylate, a propoxylated glyceryl triacrylate, a propoxylated trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, tris (2-hydroxy ethyl) isocyanurate triacrylate, di-trimethylolpropane tetraacrylate, dipentaerythritol pentaacrylate, an ethoxylated pentaerythritol tetraacrylate, a dipentaerythritol pentaacrylate, a pentaacrylate

ester, pentaerythritol tetraacrylate, or a caprolactone modified dipentaerythritol hexaacrylate.

21. A process as defined in claim 2, wherein the multi-functional monomer comprises N,N-Dimethylanimoethyl acrylate dimethylsulfate, N,N-Dimethylaminoethyl acrylate methylchloride, N,N-Dimethylaminoethyl methacrylate dimethylsulfate, N,N-Dimethylaminoethyl methacrylate methylchloride, Diallyldimethylammonium chloride, acryloxyethyldimethyl benzyl ammonium chloride, acryloxyethyltrimethyl ammonium chloride, methacryloxyethyldimethyl benzyl ammonium chloride, or methacryloxyethyltrimethyl ammonium chloride.

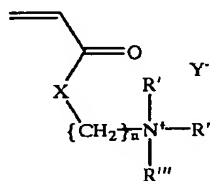
22. A process as defined in claim 2, wherein the multi-functional monomer comprises an ethoxylated trimethylolpropane triacrylate.

23. A medical device comprising:
a surface configured to move in relation to an adjacent surface; and
a lubricious coating applied to the surface, the lubricious coating comprising a quaternary amine acrylate polymer that has been cross-linked by a multi-functional monomer, the multi-functional monomer having been imbibed into the surface of the medical device, the multi-functional monomer comprising an acrylate or an ammonium compound.

24. A medical device as defined in claim 23, wherein the surface of the device is made from a thermoplastic or a thermoset.

25. A medical device as defined in claim 23, wherein the surface of the device is made from polyvinyl chloride.

26. A medical device as defined in claim 23, wherein the quaternary amine acrylate polymer comprises:



wherein n is an integer of 2 to 3; R', R'' and R''' are independently selected from the group consisting of H, C₁ to C₁₆ alkyl, aryl, arylamine, alkylamine, alkaryl and

aralkyl; X is selected from the group consisting of O and NH; and Y⁻ is an acceptable anionic counterion to the N⁺ of the quaternary amine.

27. A medical device as defined in claim 23, wherein the medical device comprises tracheal suction device, a catheter, a guidewire, a stylet, an enteral feeding device, an introducer, or an endotracheal tube.

28. A medical device as defined in claim 23, wherein the surface of the device is made from a silicone or a urethane.

29. A medical device as defined in claim 23, wherein the quaternary amine acrylate polymer comprises acryloyloxyalkyl-trialkyl-substituted ammonium salt, an acryloyloxyalkyl-aryl-substituted ammonium salt, an acrylamidoalkyl-trialkyl-substituted ammonium salt, or an acrylamidoalkyl-aryl-substituted ammonium salt.

30. A medical device as defined in claim 23, wherein the quaternary amine acrylate polymer comprises acryloyloxyethyltrimethyl ammonium chloride, or acryloyloxyethyltrimethyl ammonium methyl sulfate.

31. A medical device as defined in claim 23 wherein the multi-functional monomer comprises an alkoxylated acrylate.

32. A medical device as defined in claim 23 wherein the multi-functional monomer comprises a triacrylate.

33. A medical device as defined in claim 23, wherein the multi-functional monomer comprises a tetraacrylate, a pentaacrylate, a hexaacrylate, or a diacrylate.

34. A medical device as defined in claim 23, wherein the multi-functional monomer comprises an ethoxylated trimethylolpropane triacrylate, a propoxylated glyceryl triacrylate, trimethylolpropane triacrylate, pentaerythritol triacrylate, a propoxylated glyceryl triacrylate, a propoxylated trimethylolpropane triacrylate, trimethylolpropane trimethacrylate, tris (2-hydroxy ethyl) isocyanurate triacrylate, di-trimethylolpropane tetraacrylate, dipentaerythritol pentaacrylate, an ethoxylated pentaerythritol tetraacrylate, a dipentaerythritol pentaacrylate, a pentaacrylate ester, pentaerythritol tetraacrylate, or a caprolactone modified dipentaerythritol hexaacrylate.

35. A medical device as defined in claim 23, wherein the multi-functional monomer comprises N,N-Dimethylanimoethyl acrylate dimethylsulfate, N,N-

Dimethylaminoethyl acrylate methylchloride, N,N-Dimethylaminoethyl methacrylate dimethylsulfate, N,N-Dimethylaminoethyl methacrylate methylchloride,

- 5 Diallyldimethylammonium chloride, acryloxyethyltrimethyl benzyl ammonium chloride, acryloxyethyltrimethyl ammonium chloride, methacryloxyethyltrimethyl benzyl ammonium chloride, or methacryloxyethyltrimethyl ammonium chloride.

36. A medical device as defined in claim 23, wherein the multi-functional monomer comprises an ethoxylated trimethylolpropane triacrylate.

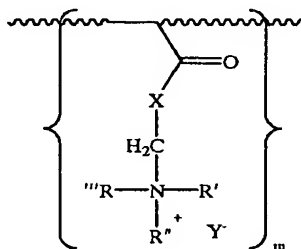
37. A process for applying a lubricious coating to the surface of a medical device comprising:

providing a medical device having a surface comprising polyvinyl chloride;

- 5 contacting the surface of the medical device with a solvent, an initiator, and a multi-functional monomer, the solvent causing the multi-functional monomer to be imbibed into the surface of the medical device, the multi-functional monomer comprising an ammonium compound;

drying the surface of the medical device;

- 10 thereafter contacting the surface of the medical device with a monomer comprising:



- 15 wherein R', R'' and R''' are independently selected from the group consisting of H, C₁ to C₁₆ alkyl, aryl, arylamine, alkylamine, alkaryl and aralkyl; X is selected from the group consisting of O and NH; Y⁻ is an acceptable anionic counterion to the N⁺ of the quaternary amine; m is an integer greater than 50,000; thereafter initiating polymerization;

polymerizing the monomer by exposing the monomer to ultraviolet light, the monomer polymerizing and forming a lubricious coating attached to the medical device.

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38. A process as defined in claim 37, wherein the solvent causes the surface of the medical device to swell.

39. A process as defined in claim 37, wherein the solvent causes the surface of the medical device to partially dissolve.

40. A process as defined in claim 37, wherein the solvent comprises dimethyl sulfoxide, acetone, methylethyl ketone, toluene, alcohol, or xylene.

41. A process as defined in claim 37, wherein a medical device is a tracheal suction device, a catheter, a guidewire, a stylet, an introducer, an enteral feeding device, or an endotracheal tube.

42. A process as defined in claim 37, wherein the hydrogel polymer is made from a monomer comprising an acryloyloxyalkyl-trialkyl-substituted ammonium salt, an acryloyloxyalkyl-aryl-substituted ammonium salt, an acrylamidoalkyl-trialkyl-substituted ammonium salt, or an acrylamidoalkyl-aryl-substituted ammonium salt.

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43. A process as defined in claim 37, wherein the hydrogel polymer is made from a monomer comprising acryloyloxyethyltrimethyl ammonium chloride, or acryloyloxyethyltrimethyl ammonium methyl sulfate.

44. A process as defined in claim 37, wherein the multi-functional monomer forms a mechanical bond with the surface of the medical device during the process.

45. A process as defined in claim 37, wherein the multi-functional monomer comprises an alkoxylated acrylate.

46. A process as defined in claim 37, wherein the multi-functional monomer comprises a triacrylate.

47. A process as defined in claim 37, wherein the multi-functional monomer comprises a tetraacrylate, a pentaacrylate, a hexaacrylate, or a diacrylate.

48. A process as defined in claim 37, wherein the multi-functional monomer comprises an ethoxylated trimethylolpropane triacrylate, a propoxylated glyceryl triacrylate, trimethylolpropane triacrylate, pentaerythritol triacrylate, a

- propoxylated glyceryl triacrylate, a propoxylated trimethylolpropane triacrylate,
5 trimethylolpropane trimethacrylate, tris (2-hydroxy ethyl) isocyanurate triacrylate,
di-trimethylolpropane tetraacrylate, dipentaerythritol pentaacrylate, an ethoxylated
pentaerythritol tetraacrylate, a dipentaerythritol pentaacrylate, a pentaacrylate
ester, pentaerythritol tetraacrylate, or a caprolactone modified dipentaerythritol
hexaacrylate.

49. A process as defined in claim 37, wherein the multi-functional
monomer comprises N,N-Dimethylanimoethyl acrylate dimethylsulfate, N,N-
Dimethylaminoethyl acrylate methylchloride, N,N-Dimethylaminoethyl methacrylate
dimethylsulfate, N,N-Dimethylaminoethyl methacrylate methylchloride,
-5- Diallyldimethylammonium chloride, acryloxyethyl dimethyl benzyl ammonium
chloride, acryloxyethyltrimethyl ammonium chloride, methacryloxyethyl dimethyl
benzyl ammonium chloride, or methacryloxyethyltrimethyl ammonium chloride.

50. A process as defined in claim 37, wherein the multi-functional
monomer comprises an ethoxylated trimethylolpropane triacrylate.